PENETRATING RADIATION AT HIGH ALTITUDES.[1]

By W. KOLHÖRSTER.

[*Reprinted from* Science Abstracts, Sect. A, Dec. 28, 1915, §1691.]

A series of experiments on the determination of the penetrating radiation present in the earth's atmosphere, have been made at various known altitudes above the earth's surface. The instrument used in measuring the ionisation was the author's modification (Sci. Abs., 1914, §888) of the Wulf type of electrometer. The following interesting table of results is given:

Height above sea level.	Difference between the number of ions per cubic meter at the height considered and on the earth's surface.	
	1913	1914
Meters.		
1,000	−1.5	.....
2,000	1.2	.....
3,000	4.0	4.3
4,000	8.3	9.3
5,000	16.5	17.2
6,000	28.7	28.7
7,000	.....	44.2
8,000	.....	61.3
9,000	.....	80.4

Assuming the relation $I = I_0 e^{-\lambda d}$ for this radiation, the value of the absorption coefficient for air at atmospheric pressure is given as 1×10^{-5} cm.$^{-1}$, whereas that of the γ-radiation from Radium C is 4.5×10^{-5} cm.$^{-1}$. This radiation is therefore extremely hard, being only reduced in intensity by 1 per cent in a layer of air (at atmospheric pressure) 7 km. in thickness. It is shown in the above manner that a very penetrating radiation exists which has its origin somewhere in space, but by far the greater part is due to the sun.—*A. B. W[ood]*.

AURORÆ, EARTH CURRENTS, AND MAGNETIC DISTURBANCES.[2]

By OTTO KLOTZ.

[Dated: Dominion Observatory, Ottawa, Canada, Oct. 23, 1915.]

[Auroræ, earth currents, and magnetic disturbances] may all be treated as a common subject or phenomenon. Let it be stated right at the outset that our ignorance of them is still vast.

The following dispatch from Winnipeg on June 17, 1915, is so interesting that it is inserted in full, besides giving an opportunity for explaining some of the statements made therein:

Aurora, more mysterious than wireless telegraphy, less constant than the visible manifestations of electrical storms, is to-day tangling up all the telegraph wires strung across the top of the continent, more especially those along the north shore of Lake Superior. There has not been such a complete tie-up in the telegraph business between eastern and western Canada for a long time, and possibly records for the month of June might be searched for many years back without finding a parallel. In fact, well-conducted auroræ confine themselves to the fall and winter months, and of all the months in the year June is most immune. The record of observations in Scandinavia and Iceland, as well as the Spitzbergen station, show no aurora at all in June, though on the North American Continent it is not unknown, though still a rare June phenomenon.

Aurora manifestations are almost entirely confined to night, and these manifestations, whether visible or not, are commonly accompanied by magnetic earth currents, and it is these properly that affect the wires. Usually with the morning sun the whole manifestation lifts, wires surcharged with excessive and variating currents are freed and released for their daily business, and the atmosphere, overloaded with electricity, becomes normal. But to-day the magnetic storm, potent though both unseen and unheard, is raging as furiously, to the tune of crackling wires at noon, as it was at midnight. The sky is heavy and overcast. When the clouds lift and the sun breaks through, the whole trouble will vanish magically as it came. For generations scientists have sought the secret of aurora and earth currents but have learned little beyond the central fact of the inconstancy of all available data on the subject.

Another peculiarity of the present visitation—a scourge alike to the telegraph companies and the daily newspapers—is that, whereas usually it is only wires running east and west that are affected by the polar visitant, on this occasion wires running north and south, such as those between Winnipeg and Minneapolis, are affected to nearly the same extent. From the meteorological point of view, this magnetic storm adds one more to the queer performances of the current month of June.

The first and natural question to occur to an observer beholding the aurora—a brilliant aurora with its dancing, shooting streamers; building, forming, and dissolving; rushing from its northern arch to meet beyond the zenith; clothed, perhaps, in greenish gauzy drapery, or yet in portentious red; ceaseless activity, a mysterious phenomenon, bewildering to mind and brain—is: What is the aurora? Beholding it gives no answer, but when we compare the phenomenon with associated ones we learn a little of its nature. We find it to be electric in its nature, an electric discharge. But here our positive knowledge about its nature stops.

We may mention the theories that have been advanced to account for the aurora. Birkeland regards the phenomenon as due to cathode rays emanating from the sun; Nordmann replaces the cathode rays by Hertzian waves; and Arrhenius supposes negatively charged particles to be sent out by the sun and reaching the earth, ionizing the upper regions of the atmosphere and thereby making it a good conductor for electrical discharges. The cathode rays we know travel at about a tenth of the velocity of light, hence would take nearly an hour and a half to reach us from the sun; the Hertzian waves at the velocity of light, i. e., 186,000 miles a second; and Arrhenius's particles would take about 46 hours, about two days for transmission. The transmission time forms an important factor when an attempt is made to associate particular sun spots and solar outbursts with particular auroræ and magnetic disturbances. The solar effect is that the discharge of the difference of potential on the earth is greatly facilitated; we have an electric current established with its consequent phenomena of auroræ, earth currents and magnetic disturbances. These are all more or less influenced by local conditions on or in the crust of the earth, and hence vary in intensity at different places. However, the strong currents encircle the earth, as we see in some notable cases, and manifest themselves particularly in magnetic disturbances and earth currents.

The electrical discharges, for of such are the auroræ, where do they take place? Many measurements and photographs (Störmer) have been made of the aurora to determine its position—height—in our atmosphere, and it has been found that the height, although varying considerably, is of the order of 50 miles. At that elevation the atmospheric pressure is only about 1/500 of an inch, about the pressure in a Geissler tube. The discharge of electricity through highly rarified gases and vapors in the large tubes, with the accompanying glow, at the Centennial Exposition in 1876, impressed the writer at the time with its close analogy and resemblance to the aurora or northern lights.

We may look upon the sun, not as the source of the magnetic disturbances, but as the medium that sets loose the bound energy residing in and on the earth.

[1] Deutsch. Phys. Gesell., Verh., July 30, 1914, 16, 14:719-721.
[2] *Reprinted from* Jour. Roy. Astron. Soc. of Canada, January, 1916, v. 10, No. 1, p. 8-14.